May 7, 1968 J. E. STACHOWIAK 3,381,780

WELL TOOL SHOCK ABSORBER

Filed April 1, 1966

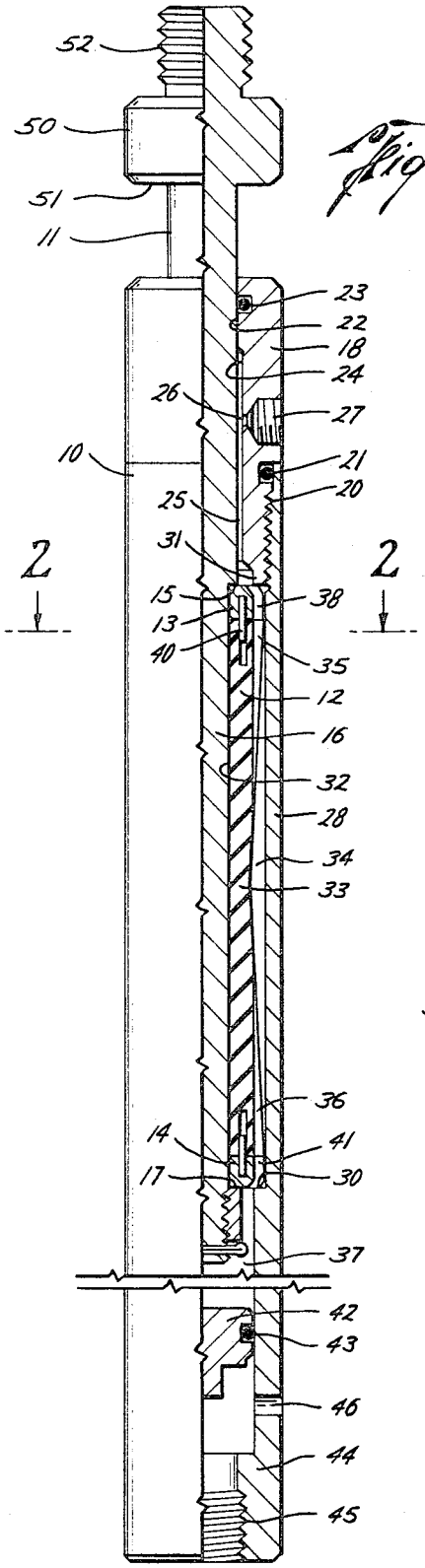


Fig. 1

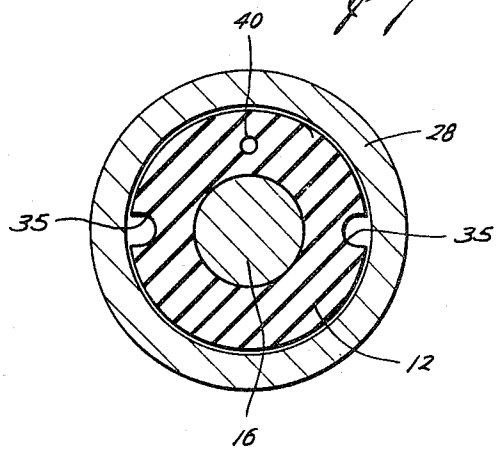


Fig. 2

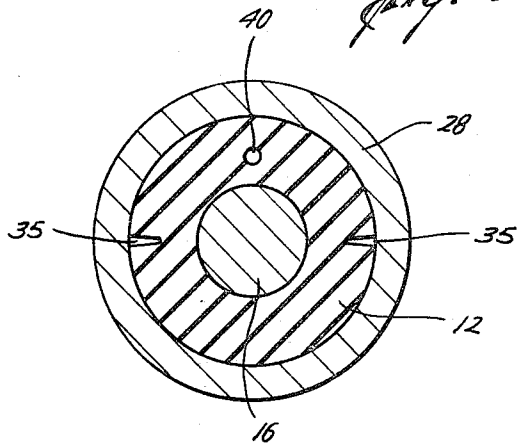


Fig. 3

John E. Stachowiak
INVENTOR.

BY

ATTORNEY

United States Patent Office

3,381,780

Patented May 7, 1968

3,381,780

WELL TOOL SHOCK ABSORBER

John E. Stachowiak, Houston, Tex., assignor, by mesne assignments, to Schlumberger Technology Corporation, Houston, Tex., a corporation of Texas

Filed Apr. 1, 1966, Ser. No. 539,393

5 Claims. (Cl. 188—86)

ABSTRACT OF THE DISCLOSURE

The particular embodiment described herein as illustrative of one form of the invention in shock absorbers includes an elastomeric member in a housing, the member forming a working chamber and a passageway in communication with the working chamber. An actuator extends into the housing and engages the member. In response to kinetic energy of a moving body, the actuator can compress the elastomeric member which functions to displace hydraulic fluid from the working chamber into an auxiliary chamber via the passageway. In response to compression of the elastomeric member, the flow area through the passageway is progressively decreased while kinetic friction between the elastomeric member and housing is progressively increased, thereby providing a resultant variable damping coefficient such that the device will impart a substantially constant rate of deceleration to the moving body.

This invention relates generally to well tools and more particularly to a device for preventing the shock loads which can be developed during the operation of a formation testing tool from damaging various parts thereof,

In evaluating a well formation for either its commercial prospects or its condition after remedial work, it is the usual practice to make a temporary completion of the well. A well tool of the type shown in the "1966–1967 General Catalogue of Johnston Testers" at p. 2894 can be used for this purpose. Such tools are generally comprised of a packer or packers to isolate the interval to be tested, a test valve assembly for selective flow control, a bypass valve to aid in running-in and retrieval of the tool, and one or more pressure recorders for recording pressure changes in the well bore. The test valve assembly is part of a removable center section which can be retrieved and rerun through the tubing when multiple well zone operations are necessary. One or more pressure recorders are attached to the lower end of the removable test valve assembly, a typical pressure recorder being shown in U.S. Patent No. 2,816,440 to Garrison, entitled, "Tension Type Pressure Recorder."

While running the tools into a fluid-filled well conduit the test valve is closed so that the tubing string above the valve is at a lower pressure than the hydrostatic mud pressure. This creates a buoyancy effect or flotation force acting upwardly on the tool. When the packer is set, the bypass closed and the test valve opened, the buoyancy effect is suddenly lost and a substantial shock load can be imparted to various parts of the tool, including the aforementioned pressure recorders which can be damaged by such shock loading because they usually include intricate clock mechanisms which rotate thin metal charts on which well fluid pressure changes are recorded.

It is accordingly the principal object of the present invention to provide a device for dissipating the energy developed during such shock loading so that tool damage which can be caused hereby is substantially minimized.

Broadly described, an apparatus which embodies the principles of the present invention comprises a case or housing having first and second chambers therein adapted to contain a hydraulic fluid, a passageway providing communication between the chambers, means including an elastomeric sleeve adapted to be compressed longitudinally of its length and expanded radially thereof for displacing hydraulic fluid from one chamber to the other via the passageway, the flow area through the passageway being variable responsive to compression and expansion of the elastomeric sleeve, and means for actuating the displacing means.

The novel features of the present invention are set forth with particularity in the appended claims. The present invention, both as to its structural organization and its operation, together with further objects and advantages thereof, may be best understood by way of illustration and example of one embodiment when taken in conjunction with the accompanying drawings in which:

FIG. 1 is a longitudinal section view of apparatus which embodies the principles of the present invention.

FIG. 2 is a cross section taken on line 2—2 of FIG. 1; and

FIG. 3 is a cross sectional view similar to FIG. 2 and illustrating the progressive decrease in flow area through the passageway during operation of the device.

Referring to FIG. 1, a cylindrical case or housing **10** receives a rod **11** for reciprocating movement therein. Slidably carried by the rod **11** is an elastomeric sleeve **12**, the sleeve being received between two compression rings **13, 14** one of which abuts against a shoulder **15** formed by a reduced-diameter portion **16** of the rod and the other abutting against the shoulder **17** provided by a nut member which is threadedly coupled to an end portion of the rod.

The upper end of the case **10** is closed by a cap or closure member **18** which is secured to the case by threads **20** or other suitable means. A seal element **21**, for example an O-ring, pressure seals the threaded joint. The closure member **18** has a centrally located opening **22** which is sized to slidably receive the rod **11**. An O-ring **23** or other suitable sealing element is positioned in an annular groove in the closure member **18** to fluidly seal against the outer surface of the rod **11**. A counterbore **24** in the closure member **18** is of larger diameter than the rod **11** to laterally space the inner wall of a portion of the closure member away from the outer surface of the rod **11** to provide an annular auxiliary chamber **25**. A fill-up port **26** through the wall of the closure member **18** permits hydraulic fluid to be introduced into the interior of the case **10** and a plug **17** sealably closes the port.

An intermediate portion **28** of the case **10** has an enlarged bore to provide an internal annular shoulder **30**. The lower compression ring **14** normally abuts against the shoulder **30** to hold the lower end of the elastomeric sleeve **12** immovable relative to the case **10** in response to downward movement of the rod **11**. The upper compression ring **13** abuts the end face **31** of the closure member **18** to hold the upper end of the sleeve **12** immovable relative to the case **10** in response to upward movement of the rod.

The elastomeric sleeve **12** has a bore **32** therethrough which is sized for sliding reception on the reduced portion **16** of rod **11**. The sleeve is of variable wall thickness, the thinnest portion **33** being intermediate the length of the sleeve and the wall thickness gradually increasing from the portion **33** toward either end, thereby laterally spacing an outer surface of the sleeve **12** from the inner wall surface of the case to provide an annular working chamber **34** therebetween. As was previously mentioned, each end of the sleeve abuts against a respective compression ring **13, 14**.

Extending from points near the mid-portion **33** of the sleeve **12** toward either end thereof are peripheral grooves or slots **35—35, 36—36** which provide passageways for

communicating the working chamber **34** with the upper auxiliary chamber **25** and a lower auxiliary chamber **37** below the end of the rod **11**. The bottom of each groove lies in a plane substantially parallel to the longitudinal axis of the sleeve **12**. Cross sectional details of the sleeve and peripheral grooves are shown in FIG. 3.

The upper compression ring **13** has radially cut slots **38—38** therein which are maintained in alignment with the grooves **35—35** by a pin **40** reecived in both the compression ring and the sleeve. The grooves **36—36** extending from the mid-portion of the sleeve to the lower end thereof are likewise aligned with radially cut slots **41—41** in the lower compression ring **14** to provide communication between the working chamber **34** and the lower auxiliary chamber **37**.

The lower auxiliary chamber **37** is closed by a balance piston **42** which is slidably received in the lower bore of the case **10**. An O-ring **43** or other suitable sealing means fluidly seals between the balance piston **42** and the inner wall of the case **10**. The lower end portion **44** of the case **10** is internally threaded at **45** for coupling to the upper end of the pressure recorder (not shown). At least one lateral port **46** through the wall of the case below the balanced piston **42** permits fluid pressure externally of the case to be transmitted into the interior of the case and via the balance piston **42** to the fluids within the aforementioned chambers **37, 34, 25** to balance the various parts of the system against the hydrostatic or submergence pressures in which the shock absorber may be immersed. Also, the balance piston **42** permits volumetric changes within the various chambers due to movement of the rod **11** and due to well bore temperature variations. Moreover, the piston **42** closes off the chambers **37, 34** and **25** from well bore fluids and prevents contamination of the hydraulic fluid by same, as well as preventing trash or other debris in the well from entering into the interior of the device.

The upper end portion of the rod **11** has an enlarged section **50** to provide an annular shoulder **51** which limits downward movement of the rod within the case **10**. Above the enlarged section **50** is a threaded portion **52** for coupling to the lower end of the removable center section (not shown) of a formation testing tool.

In operation, the parts are assembled as shown in the drawings and the upper threaded portion **52** of the rod **11** is connected to the removable center section of a formation testing tool as above dscribed and the lower end **44** of the case is coupled with the upper end of a pressure recorder. A suitable hydraulic fluid is introduced into the chambers **25, 34, 37** via the fill-up port **26**. When the formation testing tool is lowered into a fluid-filled well bore, the hydrostatic head of the well fluids is transmitted via the lateral port **46** to the balancing piston **42** and consequently to the hydraulic fluids in the chambers to pressure balance the device.

When the test valve for the testing tool is opened with a consequent loss of buoyancy, the removable center section which contains the test valve will "jump" downwardly and impart shock loading to the rod **11**. Due to such loading, the rod will move downwardly with respect to the case and the upper compression ring **13** will approach the lower compression ring **14**, thereby transmitting compressive forces to the elastomeric sleeve **12**. As the sleeve **12** is compressed, it will cold flow and expand radially into the working chamber space and displace the hydraulic fluid from the working chamber **34** into the upper auxiliary chamber **25** via the grooves **35—35** in the periphery of the sleeve. Furthermore, as the sleeve expands radially, the flow area through the grooves **35—35** will be progressively decreased because of the tendency of the elastomeric material of the sleeve to cold flow into the groove space as shown in FIG. 3. The consequent increased throttling of fluid flow through the grooves meters the flow in a manner to vary the hydraulic damping coefficient as a function of the rod stroke. Also, as the sleeve expands radially, it progressively tends to pack off against the inner wall of the case, and the unit pressure exerted by the sleeve on the case wall builds up, thereby progressively increasing the kinetic friction between the sleeve and the case wall. The kinetic friction build-up also provides a damping coefficient which varies as a function of the rod stroke. The combination of increased throttling of fluid flow through the grooves **35—35** and the build-up of kinetic friction between the sleeve and the case wall yields a resultant variable damping coefficient such that the force which resists the motion of the rod **11** is essentially constant throughout the complete rod stroke. Consequently, a substantially constant rate of deceleration is imparted thereby to a moving load, a feature which is highly desirable in shock attenuating devices.

The inherent resiliency of the elastomer material of the sleeve **12** will cause the sleeve to return to its original shape and the rod **11** and the case **10** to return to their original relative positions. No sudden rebounding effect is present because the hydraulic fluid displaced into the auxiliary chamber **25** will be metered back into the working chamber **34**, the metered flow occurring through a progressively increasing flow area of the grooves or slots **35—35**.

It will be appreciated that the apparatus shown in the drawing is double acting, e.g., if a moving load should cause movement of the rod **11** upwardly with respect to the case **10**, variable hydraulic damping will occur due to fluid displaced from the working chamber **34** into the lower auxiliary chamber **37** via the lower peripheral grooves **36—36** in the sleeve, with like friction damping forces acting in a direction opposite to those above described. It will be understood, however, that although the invention is shown embodied in a double acting device, certain or all of its features might be employed in other types of energy dissipating devices and it is not intended to limit the invention to the first named type.

Apparatus has been disclosed which provides effective energy dissipation for the shock loading which can be developed during the operation of a formation testing tool. It has been found that tool damage due to such shock loads has been substantially minimized to the unique features of the subject invention. Since certain changes and modifications may be made in the disclosed apparatus without departing from the scope of the inventive concept involved, it is intended that all matter contained in the foregoing description and shown in the attached drawings shall be interpreted as illustrative and not in a limited sense.

I claim:

1. A shock load attenuating device comprising:

a casing forming a cylinder, said casing having a first chamber therein;

a generally tubular elastomer member in said casing, said member having an outer surface thereof laterally spaced from the internal wall surface of said housing to define a second chamber, said chambers containing a hydraulic fluid;

passageway means providing communication between said first and second chambers; and

means for compressing said elastomeric member whereby radial expansion thereof is effective to displace the hydraulic fluid from said second chamber into said first chamber via said passageway means, the compression and expansion of said member acting to progressively decrease the flow area through said passageway means and to progressively increase the unit pressure exerted by the member on the internal walls of the cylinder.

2. Apparatus for dissipating the kinetic energy of a moving body comprising: a housing; elastomeric means in said housing forming a first chamber and a passageway in communication with said first chamber, said first chamber containing a hydraulic fluid; a second chamber

in communication with said passageway; an actuating means extending into said housing movable relative thereto and engaging said elastomeric means to transmit compressive force thereto in response to kinetic energy of a moving body to effect deformation of said elastomeric means, whereby deformation of said elastomeric means effects displacement of hydraulic fluid from said first chamber into said second chamber via said passageway and progressive decrease in flow area through said passageway, said actuating means including a longitudinally extending rod, said elastomeric means being deformable radially outwardly of the axis of said rod upon movement of said rod relative to said housing, said elastomeric means being a generally tubular member slidably mounted on said rod; and coengageable means between at least one end of said tubular member and said housing for preventing movement of said one end relative to said housing during deformation of said tubular member.

3. Apparatus for dissipating the kinetic energy of a moving body comprising: a housing; an elongated elastomeric means in said housing forming a first chamber and a passageway in communication with said first chamber, said first chamber containing a hydraulic fluid; a second chamber in communication with said passageway; means for preventing movement of one end of said elastomeric means in said housing in one longitudinal direction; and actuating means extending into said housing and movable in said longitudinal direction, said actuating means including means engaging the other end of said elastomeric means to transmit compressive force

thereto and effect deformation of said elastomeric means in response to kinetic energy of a moving body, said deformation effecting displacement of hydraulic fluid from said first chamber into said second chamber via said passageway and progressive decrease in flow area through said passageway.

4. The apparatus of claim 3 wherein said actuating means comprises a rod, said elastomeric means being deformable axially and radially with respect to said rod by said compressive force.

5. The apparatus of claim 3 further including means for balancing said actuating means against the submergence pressures of fluids in which the apparatus may be immersed, and for permitting volumetric changes within said housing during movement of said actuating means.

References Cited

UNITED STATES PATENTS

2,212,759	8/1940	Tea	188—129 X
2,752,149	6/1956	Forcellini	188—86 X
2,856,035	10/1953	Rohacs	188—100 X
3,109,520	11/1963	Vossieck	188—86 X

FOREIGN PATENTS

1,055,443	10/1953	France.
1,083,043	6/1954	France.

MILTON BUCHLER, *Primary Examiner.*

G. E. A. HALVOSA, *Assistant Examiner.*